

Finger Gangrene Caused by Small Artery Occlusive Disease

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Available evidence indicates that about one third of all patients presenting with localized finger gangrene develop the condition due to intrinsic occlusions of the small arteries of the hand and fingers caused by one of a variety of systemic diseases. We have treated 35 such patients in the past seven years. A variety of diagnostic tests allowed the establishment of the diagnosis of connective tissue disease in 14 patients, hypersensitivity angiitis in 13 patients, arteriosclerosis in five patients, and myeloid metaplasia, calciphylaxis, and carcinoma in one patient each. Treatment with cold and tobacco avoidance, vasodilators, and local debridement produced good results without amputation in 30 patients. Five patients required partial phalangeal amputation. These results suggest that appropriate diagnostic tests will allow an accurate diagnosis in all patients, and that the natural history is that of spontaneous improvement without major tissue loss. In our experience, surgical sympathectomy plays no role in the treatment of these patients.

ISCHEMIC FINGER GANGRENE may be caused by large artery occlusions proximal to the wrist which may be amenable to surgical therapy or by diffuse occlusive sclerosis of the palmar and digital arteries. Available evidence suggests that approximately two thirds of patients presenting with localized finger gangrene have large artery obstruction proximal to the wrist, resulting from such diverse causes as subclavian artery occlusion or aneurysm with or without thoracic outlet arterial compression, trauma, including iatrogenic trauma, emboli from proximal sources, or atherosclerosis. The nature of these lesions and their treatment have been well described.^{6,18}

The remaining one third of patients with finger gangrene have systemic diseases of which diffuse occlusions of the palmar and digital arteries is one manifestation. It may seem that the diagnosis and treatment of these conditions should properly be the concern of immunologists, rheumatologists, and dermatologists. Our experience indicates, however, that once finger gangrene occurs, surgeons frequently become involved

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in establishing the definitive diagnosis and prescribing treatment for these patients.

In the past seven years, we have treated 35 patients who presented with finger gangrene resulting from diffuse small artery occlusive disease of the palmar and digital arteries. Our experience with their diagnostic evaluation, initial treatment, and long-term follow-up forms the basis for this report.

Patient Description

Only patients with ischemic finger gangrene and angiographically determined diffuse small artery occlusive disease are included in this report. Extrinsic causes of small artery occlusions such as cold injury, inadvertent intra-arterial drug injections, embolization from proximal sources, trauma, and ergot intoxication were specifically excluded. Also excluded were patients with only small hyperkeratotic plaques of the finger tips which represent the mildest form of finger ischemic necrosis and are commonly seen with connective tissue diseases.

The 35 patients selected for study all had significant gangrenous changes of the distal portions of one or more fingers (Fig. 1). These patients were selected from a group of over 300 patients referred for our ongoing study of hand and finger ischemia, the general characteristics of which have been reported previously.¹⁹ These 35 patients include 23 women and 12 men, who ranged in age from 12–75 years, with a mean age of 45 years.

Method of Presentation

The patients were easily divisible into two groups on the basis of whether they presented with an acute or chronic history of finger gangrene. Twenty patients presented within weeks to a few months of the acute onset of finger ischemia. They typically described

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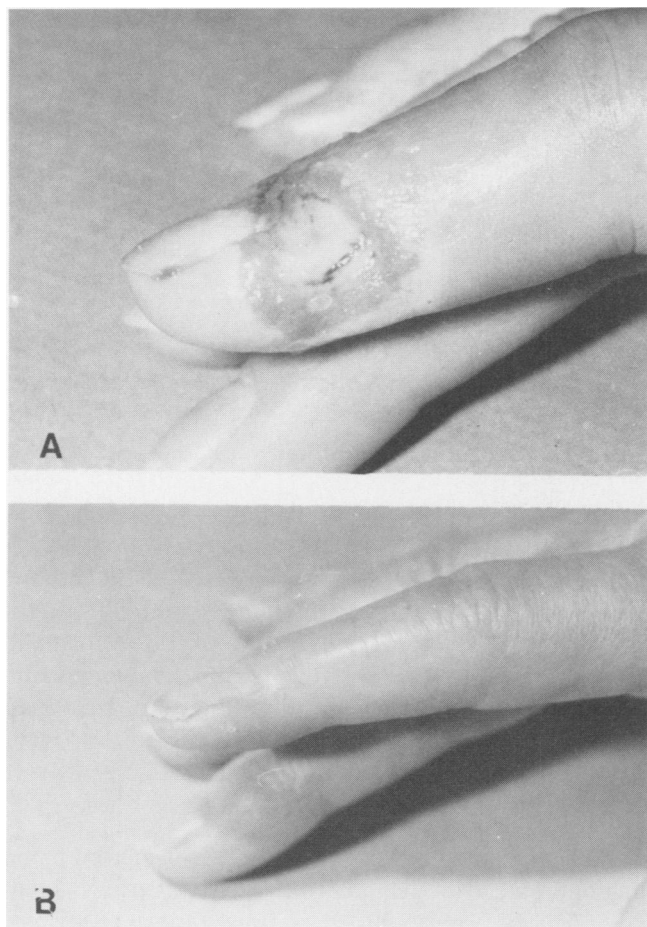


FIG. 1. Scleroderma. Gangrenous lesion of index finger in a 60-year-old female smoker. (a) Initial presentation. (b) Healing after one month of conservative therapy and cessation of tobacco use.

the rapid, sometimes sudden onset of cyanosis and pain at the tips of one or more fingers, blanching with cold exposure, and the rapid development of areas of skin necrosis and gangrene. Systemic symptoms and signs of connective tissue or other diseases were absent in all but one patient who had obvious scleroderma. Several patients had been treated for presumed bacterial ulcerations for varying periods before recognition of the underlying ischemic nature of the problem. These patients in the acute presentation group were younger, more often female, and less likely to be smokers than those first seen for chronic finger ischemia. Six of the 20 patients had Raynaud's syndrome prior to the onset of severe ischemic symptoms.

Fifteen patients presented with a history of chronic changes of finger gangrene, often with multiple exacerbations and remissions for an average duration of eight years. Patients in this group averaged nine years older than those in the acute presentation group. Two patients in this group had previously diagnosed connective tissue disorders, one lupus and one scleroderma.

All of these patients had chronic Raynaud's syndrome. Two had undergone previous cervicothoracic sympathectomy without benefit. Two had had prior partial finger amputations. Table 1 summarizes the presenting data for both acute and chronic patient groups.

Diagnostic Evaluation

All of these patients were evaluated in the Clinical Research Center of the University of Oregon Health Sciences Center on a protocol investigation specifically designed to elucidate causes of finger ischemia.

Patients were carefully questioned and examined for signs and symptoms of connective tissue disorders including arthritis, arthralgias, myalgias, skin rash, alopecia, sclerodactyly, dysphagia, xerostomia, xerophthalmia, weakness, oropharyngeal ulceration, depression, emotional lability, and seizures. Angina pectoris, TIA's or stroke, claudication and diminution or absence of arterial pulses in the extremities were used as preliminary indications of arteriosclerosis. Multiple level extremity blood pressures and treadmill walking tolerance tests were obtained in patients with diminished or absent extremity pulses. Trauma, heavy metal ingestion, emboli, thoracic outlet syndrome, and past cold injury were all carefully ruled out. Sequential color photographs of the hands were obtained on all patients.

Arteriography

Magnification hand arteriography, including all vessels of the upper extremity from the aortic arch to the finger tips, was performed in 34 of the 35 patients. Arteriography was deferred in the single child in this series. This 12-year-old girl had classic serologic changes of mixed connective tissue disease and markedly abnormal digital plethysmography diagnostic of severe obstructive disease. These arteriograms were done by transfemoral Seldinger technique both before and after ice exposure and before and 48 hours after

TABLE 1. Characteristics of 35 Patients with Finger Gangrene

	Acute Onset	Chronic	All Patients
Males	6 (32%)	6 (38%)	12 (34%)
Females	14 (68%)	9 (62%)	23 (65%)
Age (mean)	40	49	45
Smoking	13 (59%)	11 (84%)	24 (69%)
Diabetes	0	0	0
Systemic atherosclerosis	0	6 (46%)	6 (17%)
Preestablished connective tissue disease	1 (4%)	2 (15%)	3 (9%)
Raynaud's syndrome prior to gangrene	6 (27%)	13 (100%)	19 (54%)
Total	20 (63%)	15 (37%)	35

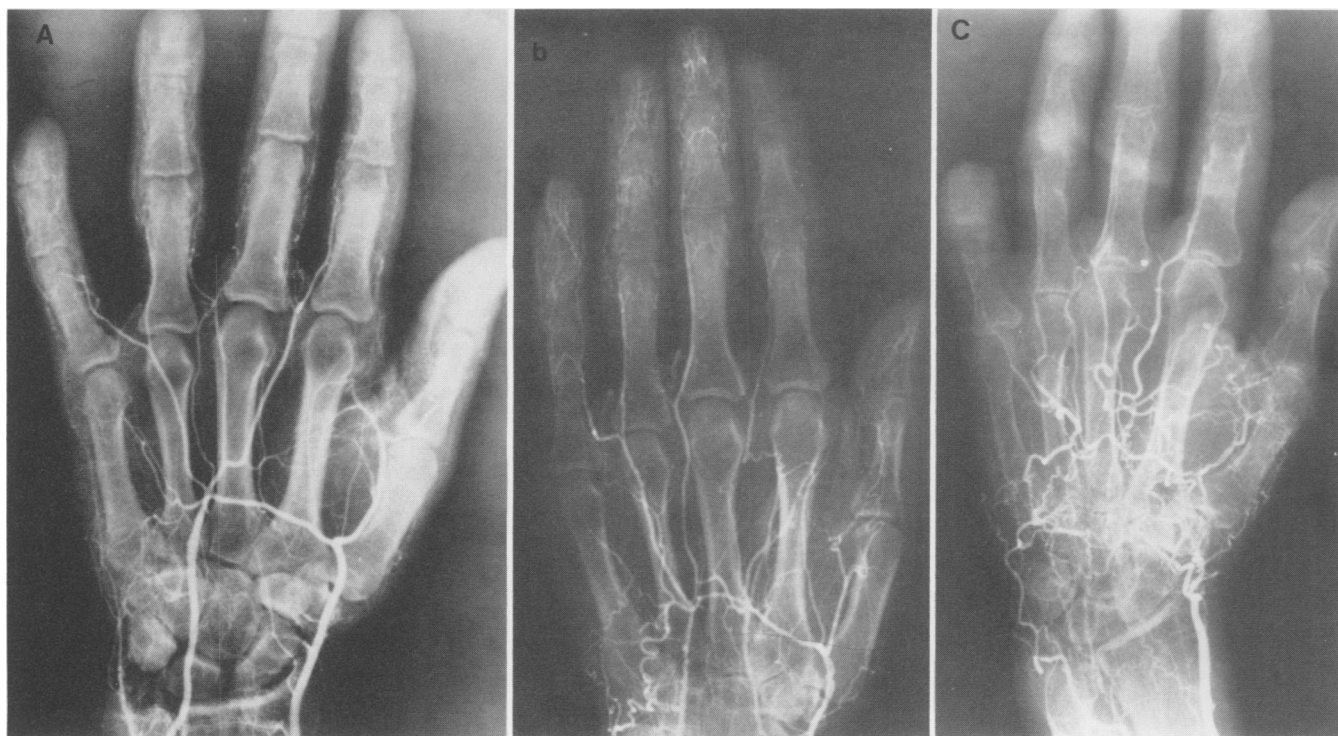


FIG. 2. Magnification hand arteriograms demonstrate widespread common and proper digital arterial occlusions in patients with (A) hypersensitivity angitis (note also total occlusion superficial palmar arch), (B) hypersensitivity angitis (note also occlusion of ulnar artery at wrist and deep palmar arch), (C) arteriosclerosis (note occluded ulnar artery and both palmar arches occluded).

the intra-arterial injection of reserpine as previously described by Rösch from this institution.²⁰ Arteriography remains the single most valuable diagnostic test in evaluation of these patients, providing objective information about the nature, location, and distribution of arterial obstructions, the extent of development of collateral vessels and, when performed with ice and reserpine exposure, quantification of the degree of vasospasm present in addition to the underlying occlusive disease. Response to vasodilating agents can also be noted.

All patients showed evidence of diffuse occlusions and stenoses of multiple palmar and digital arteries. Multiple occlusions of common and proper digital arteries were present in every patient with occlusion of superficial and/or deep palmar arch present in nine patients and occlusions of radial and/or ulnar arteries at the wrist in 13 patients. No patients had any arterial occlusions or suspected sources of emboli proximal to the wrist. No patients demonstrated isolated or highly localized disease. Widespread multiple occlusions distal to the wrist were a constant finding. Typical arteriograms are shown in Fig. 2.

Abnormal vasospasm as measured by prolonged vasoconstrictor response to ice water immersion as revealed by arteriography, which responded to intra-

arterial reserpine, was present in 11 of these patients. The amount of vasospasm revealed, however, was much less than that seen in a previous group of Raynaud's patients without such widespread arterial occlusion.²⁰ The vasospasm encountered was far less impressive than the massive arterial obstruction invariably present.

Laboratory Examination

Once arteriography identified those patients with diffuse small artery occlusive disease, a series of detailed laboratory examinations were obtained in an attempt to detect any coexisting systemic illness. Complete blood count, sedimentation rate, multichem screen, 24-hour urine for creatinine/creatinine ratio, chest x-ray, hand x-ray, and upper gastrointestinal series, barium enema, and intravenous urograms were performed in all patients as was digital plethysmography. Skin biopsies were obtained from most. All patients were subject to extensive serum immunologic screening tests as outlined in Table 2.

Diagnoses Established

The diagnoses responsible for finger gangrene in the 35 patients are summarized in Table 3.

TABLE 2. *Immunologic Tests*

Serum protein electrophoresis
Cold agglutins
Rheumatoid factor (latex particle)
VDRL
Antinuclear antibody
Hep-2 ANA ⁴
Antinative DNA antibody ⁵
Extractable nuclear antibody ⁶
Total hemolytic complement
Complement (C3, C4)
Immunoglobulin electrophoresis
Cryoglobulin (Cryocrit)
Cryofibrinogen
Direct Coomb's test
Hbs Ab—hepatitis B antibody
Hbs Ag—hepatitis B antigen

References refer to methodology for those determinations not routinely performed in most clinical laboratories.

Hypersensitivity Angiitis

Thirteen patients presented with a history of abrupt onset of distal finger gangrene secondary to extensive occlusions of the palmar and digital arteries. They were remarkable for the absence of associated findings of any underlying disease either by clinical or laboratory examination. These patients, including eight women and five men ranging in age from 21–53 years (mean: 39 years), were all smokers but one, and none had prior Raynaud's syndrome. The detailed characteristics of ten of these patients, who are felt to represent a new clinical syndrome, have been described in a previous report.⁵ Each of these patients showed extensive arterial obstructions on angiography. Most also showed vasospasm as confirmed by improved blood flow on angiograms performed 48 hours after intra-arterial reserpine injection.

Scleroderma

Seven patients were diagnosed as having scleroderma or CREST syndrome, six of whom presented with chronic symptoms of recurrent finger gangrene. Clinical diagnostic criteria of Barnett⁴ were used to confirm this diagnosis. These patients included six women and one man ranging in age from 22 to 67 years (mean: 51 years). All had Raynaud's syndrome present for at least one year prior to occurrence of gangrene. All but one presented with chronic histories of repeated episodes of finger gangrene. All had thickened, bound down, leathery skin of the hands, forearms, and fingers. All had telangiectasias. Six had digital subcutaneous calcium deposits. The four who had skin biopsies all showed increased dermal and subdermal collagen compatible with scleroderma. Arteriography in these patients showed widespread palmar and digital arterial occlusions with little or no vasospasm. The single patient

who presented in an acute stage was a 22-year-old woman with a one-year history of Raynaud's syndrome followed by gangrene of three finger tips which healed with conservative treatment. Three years later severe Raynaud's syndrome recurred with sclerodactyly, telangiectasias, and digital calcinosis, together with the appearance of positive antinuclear antibody, cold agglutinins, and Coomb's test allowing the definitive diagnosis of scleroderma. This emphasizes that digital ischemia may precede the development of frank scleroderma by many years.¹⁴

Arteriosclerosis

Five patients were diagnosed as having arteriosclerotic digital artery occlusions. None had diabetes. They ranged in age from 42 to 65 years (mean: 52 years) and included three men and two women. All were heavy smokers, and all had clear evidence of generalized arteriosclerosis including diminished or absent peripheral pulses as confirmed by clinical as well as vascular laboratory examinations. All presented with chronic histories of Raynaud's syndrome and finger gangrene, which was characteristically random in distribution, sparing some fingers, or occasionally an entire hand. Arteriography showed occlusive arterial lesions in multiple areas. Vasospasm was present in moderate degree in several patients in spite of the apparent fixed nature of the arteriosclerotic obstructions. One of these patients, a 42-year-old man, had Type II hyperlipidemia. None of these patients had any serologic abnormalities associated with connective tissue diseases.

Undifferentiated Connective Tissue Disease

Three patients were felt to have definite laboratory and clinical evidence of connective tissue disease but lacked the precise spectrum of diagnostic findings to

TABLE 3. *Final Diagnoses of 35 Patients with Finger Gangrene from Intrinsic Small Artery Occlusive Disease*

	Acute	Chronic	Total
Hypersensitivity angiitis			
suspected	12	1	13
Scleroderma—CREST	1	6	7
Arteriosclerosis	0	5	5
Undifferentiated connective			
tissue disease	3	0	3
Mixed connective tissue disease	1	1	2
Systemic lupus erythematosus	1	0	1
Sjogren's syndrome	0	1	1
Myeloid metaplasia	1	0	1
Calciphylaxis	0	1	1
Carcinoma	1	0	1
Total	20	15	35

place them in any one category, a condition currently described as undifferentiated connective tissue disease.¹⁶ All were women, aged 24, 32, and 47 years, respectively. Only one smoked. All had the acute onset of digital ischemia and gangrene without preexisting Raynaud's syndrome. The 24-year-old was initially felt to have hypersensitivity angiitis but then developed a positive antinuclear antibody test. The 32-year-old has severe arthritis which has remained seronegative. All three had extensive arterial obstructions with little or no vasospastic element.

Mixed Connective Tissue Disease

Two patients fulfill the diagnostic criteria for mixed connective tissue disease as described by Sharpe.²¹ A 12-year-old female patient presented with a five-year history of Raynaud's syndrome and two years of recurrent finger ulcerations and tissue loss. A 45-year-old man gave a five-year history of Raynaud's syndrome and finger ulcerations. He had had prior bilateral cervicothoracic sympathectomy and several partial finger amputations. Both had positive antinuclear antibody tests, antibodies to ribonuclease sensitive extractable nuclear antigens, and increased sedimentation rate. Both had obstructive patterns on digital plethysmography. The child was not given an angiogram; the male patient had widespread digital artery and palmar arch occlusions.

Systemic Lupus Erythematosus

A single patient satisfied the American Rheumatism Association criteria for SLE.⁹ She was a 45-year-old female smoker with a chronic history of Raynaud's syndrome and gangrenous ulcerations of two fingers. Antinuclear antibody and antinative DNA were strongly positive. Angiography demonstrated multiple digital occlusions without significant vasospasm.

Sjogren's Syndrome

A 60-year-old woman with xerophthalmia and xerostomia without other laboratory abnormality had a 20-year history of Raynaud's syndrome and recurrent necrotic finger ulcerations. Salivary gland biopsy revealed typical Sjogren's syndrome. Angiography showed multiple occlusions without evidence of vasospasm. The recognition of Sjogren's syndrome as a bonafide rheumatic disorder and its occasional association with systemic arteritis has been described in a recent report.¹³

Myeloid Metaplasia

A 75-year-old female nonsmoker with myeloid metaplasia developed large gangrenous ulcers of two fingers



FIG. 3. Plain hand x-rays of 40-year-old male renal transplant recipient demonstrate extensive vascular calcifications (calciphylaxis).

without previous history of Raynaud's syndrome. Arteriography demonstrated widespread digital artery occlusions. Thrombosis was secondary to thrombocytosis with a platelet count of over 1 million/mm³.

Calciphylaxis

A 40-year-old male renal transplant recipient developed gangrene of multiple fingers associated with widespread vascular calcification. The hand x-ray on this patient is shown in Fig. 3. This condition has been described as calciphylaxis.¹²

Globulin Producing Carcinoma

A 63-year-old female patient with sudden onset of Raynaud's syndrome and gangrenous finger ulcers was found to have multiple digital occlusions as shown by arteriography. Serologic evaluation revealed massively elevated gamma globulins. Additional evaluation revealed a carcinosarcoma of the kidney. Removal of the tumor resulted in normalization of the serum proteins and resolution of symptoms. This patient has been previously described.²

Approach to Treatment

We have directed therapy at three main points. First, elimination of any vasospasm was attempted by stressing cold avoidance and cessation of tobacco use. Most patients were given oral guanethidine (10 mg/day) and/or phenoxybenzamine (10 mg/day). More recently, prazosin (1–2 mg/day) has been used alone or in combination with the others. All of these agents have been successful in relieving digital vasospasm associated with Raynaud's syndrome.

TABLE 4. Treatment Results in 35 Patients with Finger Gangrene

Diagnosis	Healed with No Symptoms	Healed with Raynaud's Syndrome	Healed Amputation	Amputations with Recurrent Gangrene
Hypersensitivity angiitis (13 patients)	7	5		
Scleroderma (7 patients)		6		1
Arteriosclerosis (5 patients)	2	1		2
Undifferentiated connective tissue disease (3 patients)	2	1		
Mixed connective tissue disease (2 patients)		2		
Lupus			1	
Sjogren's syndrome		1		
Calciophylaxis				1
Myeloid metaplasia	1			
Carcinoma	1			
Total	13	16	1	4
		30 good results (86%)		5 poor results including 1 patient lost to follow-up (14%)

We have very recently begun evaluation of reserpine administered intravenously below an occlusive tourniquet, (as in Bier block regional anesthetic technique) as first described by Chuinard in the treatment of reflex sympathetic dystrophy.⁸ Our preliminary results indicate this is an effective method of eliminating vasospasm in the affected extremity for one to two weeks.²²

Second, basic simple wound care was stressed. Gangrenous ulcers were scrubbed with soap and water twice daily and covered with dry gauze bandages. Antibiotics appropriate to culture results were used for lesions with surrounding cellulitis. Conservative surgical debridement of necrotic tissue was performed as needed and frequently included localized rongeur of protruding phalangeal tips. Formal phalangeal amputation was performed only when an entire digital segment (*i.e.*, total phalanx) was necrotic.

Third, appropriate medical therapy to control underlying systemic illness was stressed. Surgical sympathectomy was not performed by us in any patients, although two patients had undergone this procedure prior to referral to our institution.

Results of Treatment

One patient moved from the area and was lost to follow-up. The others have been continuously observed from four to 91 months (average: 33 months).

The overall results of treatment for each diagnostic category are outlined in Table 4. Thirteen (37%) of the 35 patients (seven with hypersensitivity angiitis, two with undifferentiated connective tissue disease, two with arteriosclerosis, one with myeloid metaplasia, one with carcinoma) required no amputation and have had complete healing of all lesions with no resid-

ual symptoms. Sixteen patients (46%) (six with scleroderma, five hypersensitivity angiitis, two mixed connective tissue disease, one undifferentiated connective tissue disease, one Sjogren's syndrome, one arteriosclerosis) have had complete healing of all lesions with only mild residual Raynaud's syndrome. Five of these patients (two with mixed connective tissue disease, two undifferentiated connective tissue disease, one hypersensitivity angiitis) have had a single recurrent episode of finger gangrene which has healed promptly without amputation.

Five patients (14%) (two with arteriosclerosis, one lupus, one scleroderma, one calciophylaxis) have had persistent nonhealing and/or multiple recurrences and have required one or more phalangeal amputations. One patient with lupus has had complete healing after phalangeal amputation and has no residual symptoms. The other four continue to have recurrent episodes of finger gangrene. The single patient lost to follow-up had hypersensitivity angiitis with multiple recurrent episodes of finger gangrene.

Thirty of 35 patients have experienced good results and are presently either asymptomatic or only have mild Raynaud's symptoms. Four patients continue to experience recurrent episodes of digital gangrene, and all have required at least one phalangeal amputation. Except for the man with calciophylaxis, all patients with recurring digital gangrene after amputation have been heavy smokers who have been unable to stop. By diagnosis, those with arteriosclerosis had the worst prognosis (40% poor results) while those with hypersensitivity angiitis had the best (84% good results).

Although vasospasm appeared to play a minimal role in the production of these patient's gangrenous lesions, relief of vasospasm was coincident with rapid healing in some patients. In most patients, healing occurred

over weeks to months and was associated with the development of collateral circulation as documented by the sequential arteriograms as seen in Figure 4.

Ten patients were able to stop smoking cigarettes (six with hypersensitivity angiitis, three scleroderma, one arteriosclerosis). All had good results.

Discussion

A comprehensive list of recognized causes of intrinsic small artery occlusive disease appears in Table 5, with the number of patients from the present study indicated in parentheses. Twenty-seven of our 35 patients suffered from a connective tissue or autoimmune disease, and the palmar and digital artery obstruction in these patients presumably resulted from associated arteritis.

Only one of the 35 patients had a diagnosis of connective tissue disease established before referral here, and none had any finding on history or clinical examination which allowed the immediate diagnosis of one of the connective tissue disorders. Detailed laboratory investigation with particular emphasis on the many antinuclear antibodies now being recognized was essential in permitting the firm diagnosis of connective tissue disorders before definite clinical manifestations other than finger gangrene were present. In this regard the Hep-2 antinuclear antibody test has been particularly sensitive, often being positive in patients with early sclero-

TABLE 5. Possible Causes of Intrinsic Small Artery Disease in Patients in Present Study

Connective tissue diseases and other arteritides
scleroderma CREST (7 patients)
rheumatoid arthritis
Sjogren's syndrome (1 patient)
systemic lupus erythematosus (1 patient)
polyarteritis nodosa
mixed connective tissue disease (2 patients)
undifferentiated connective tissue disease (3 patients)
Wegener's granulomatosis
allergic granulomatosis
Henoch-Schönlein purpura
hypersensitivity angiitis (13 patients)
Myeloproliferative disorders
polycythemia rubra vera
thrombocytosis
leukemia
myeloid metaplasia (1 patient)
Immunoglobulin abnormalities
mixed cryoglobulinemia
myeloma or benign monoclonal gammopathy
macroglobulinemia
cold agglutinin disease
tumor produced globulins (1 patient)
Miscellaneous
systemic malignancy
disseminated intravascular coagulation
chronic renal failure (calciophylaxis) (1 patient)
arteriosclerosis (5 patients)
Buerger's disease

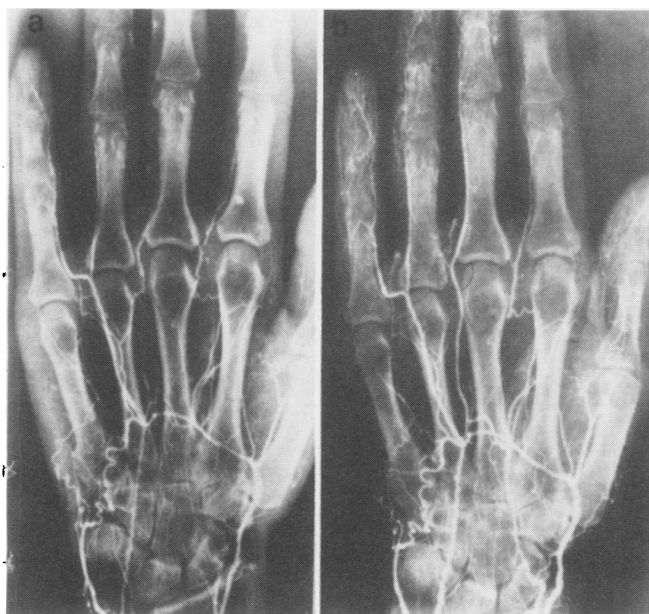


FIG. 4. Hypersensitivity angiitis. Serial arteriograms demonstrate development of collateral circulation in a 44-year-old man. (a) Marked common and proper digital artery obstruction associated with gangrenous finger lesions. (b) Three years later collaterals have appeared, the lesions have healed and there are no residual symptoms.

derma before any other laboratory tests.¹ The observation that each advance in laboratory identification of immunologic abnormalities has allowed identification of underlying disorders in a greater proportion of our patients with hand and finger ischemia supports our belief that all of these patients will ultimately be recognized as having an associated disease process, a position originally stated by deTakats.¹¹

We have classified 13 patients in this review as having hypersensitivity angiitis, which we have characterized as a disorder manifested by the acute onset of extensive severe small artery occlusive disease of the palmar and digital arteries in the absence of identifiable clinical or laboratory evidence of any known underlying disorder. Since our original description of ten patients with this condition,⁵ we have encountered five additional, similar patients. Two patients originally classified in this group have subsequently developed clinical and/or laboratory evidence of an underlying connective tissue disease. One was the 22-year-old woman who developed classic CREST syndrome three years after first being seen with acute finger gangrene without accompanying abnormality. The second was a 24-year-old woman who presented with acute finger gangrene without other positive findings and two and one half years later has been found to have a positive antinuclear antibody test. She is included in this review

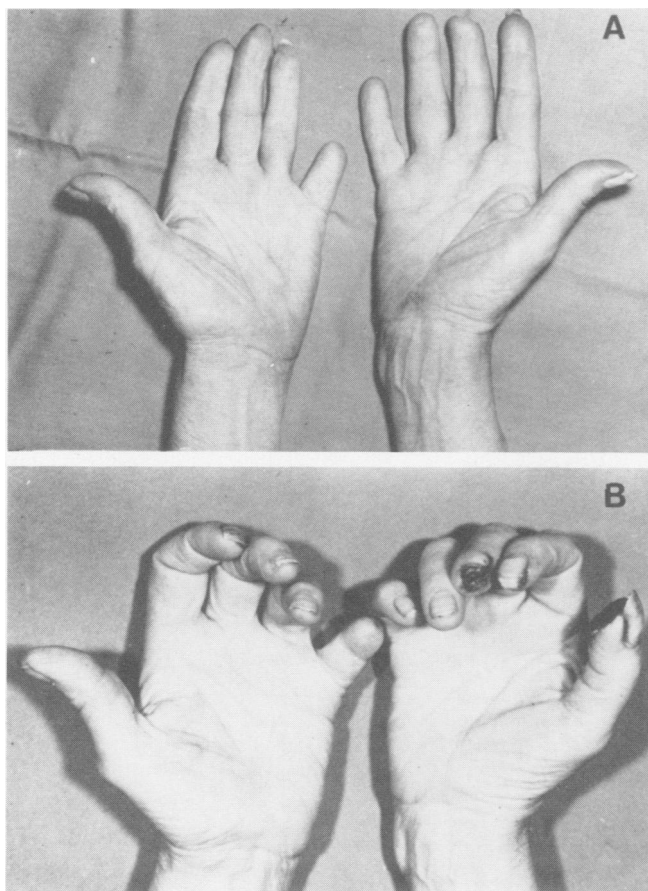


FIG. 5. (A) Typical complete healing. Three months after presentation with (B) extensive gangrenous lesions of multiple fingers. The patient was a 58-year-old female smoker with arteriosclerosis who had conservative therapy only.

in the diagnostic category of undifferentiated connective tissue disease. We recognize that with continued observation other patients in the hypersensitivity angitis group may well develop changes of classic connective tissue disorders known to be associated with intrinsic small artery occlusive disease.

Although all 35 patients in this report had localized distal finger gangrene when first seen, the overall results after almost three years average follow-up have been good with 86% permanent healing, and only five patients (14%) requiring phalangeal amputation. We believe that these results reflect a profound difference between the natural history of finger gangrene from small artery occlusions and the more commonly encountered gangrenous conditions of the lower extremity due to large artery obstructions. It is extremely important to recognize that gangrene of the fingers from intrinsic small artery disease does not herald an inexorable progression to major tissue loss. Rather, in these 35 patients, it appears that the natural history of the disorder, regardless of cause, is one of short periods of exacerba-

tion with the development of gangrenous distal lesions, followed by long periods of remission with healing and stable mild symptoms. Our realization of this basic pattern of disease course was prompted by initial experience with the patients described above with chronic histories of finger gangrene, some of whom had experienced repeated episodes of gangrenous changes for up to 20 years, but without major tissue loss, and always with ultimate healing. It was confirmed by our experience in the treatment of the patients first presenting with acute gangrenous changes, in whom conservative treatment only gave good results in most patients, with the pattern of disease conforming as expected to that defined by the histories of the patients with chronic symptoms (Fig. 5).

The elucidation of this basically benign prognosis has major therapeutic implications. It is unclear to what degree our therapy of simple wound care and low-dose oral vasodilators has been responsible for the overall good results in 86% of these patients. We suspect that this outcome in significant part reflects the natural history of the condition. Beneficial results claimed for any mode of therapy in the past or in future studies must be carefully evaluated against this standard. This is particularly true of cervicothoracic sympathectomy which has been recommended as appropriate therapy for finger gangrene of small artery origin. Dale has described 83% healing after sympathectomy in six patients with digital gangrene.¹⁰ Laroche, *et al.*, reported 78% of 64 patients improved by sympathectomy,¹⁵ most of whom had symptoms far less severe than those described in the present report. Machleder, *et al.*, again in a series of patients with less severe disease than those in this report, had 81% good results with sympathectomy.¹⁷ These results of sympathectomy are obviously no different from those herein reported with conservative treatment only. We are aware of no persuasive evidence that cervicothoracic sympathectomy has any beneficial effect in the treatment of upper extremity ischemia from small artery disease.

The influence of vasospasm in these patients is difficult to define, but appears minimal. Most do not show significant vasospasm on cryodynamic hand angiography, although some have some small degree of vasospasm, and an objective response to vasodilating agents can be demonstrated. The major underlying lesion, however, is fixed organic arterial occlusions. Most often, improvement of finger perfusion appears to occur with the slow development of collateral circulation (Fig. 4), and modification of vasospasm would appear to offer limited benefit. Nonetheless, we have persisted in the administration of alpha receptor blocking drugs despite the absence of controlled studies supporting this position.

The effect of cigarette smoking is more clear. All patients but one with poor results were heavy smokers. All patients who stopped smoking had good results. Overall, 71% of these patients with finger gangrene were smokers, compared with 36% of the larger group of over 300 patients with hand ischemia without gangrene who have a similar spectrum of diagnoses.

In summary then, we make the following recommendations for physicians evaluating and caring for patients with finger gangrene from intrinsic small artery occlusive disease:

1) Arteriography allows differentiation of proximal large artery obstruction from distal small artery occlusive disease.

2) Detailed clinical and laboratory evaluation allow a precise diagnosis of underlying disease in almost all patients, although sequential observation over years may be required in some patients before establishing a diagnosis. Most of these patients have arteritis, most commonly caused by connective tissue disease.

3) The prognosis for healing without major tissue loss is excellent. Simple conservative therapy with low-dose vasodilators and basic wound care is sufficient in approximately 80% of patients. Our experience suggests that about 15–20% of these patients will require local phalangeal amputations. All patients should be encouraged to stop smoking.

4) The natural history of this condition appears to be one of steady improvement interspersed with minor recurrences in occasional patients. Progression to major finger or hand amputation occurs infrequently and then only in patients who are unable to quit smoking.

5) We can find no convincing evidence that surgical sympathectomy is of any benefit in the treatment of this condition.

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